SQUIRE SANDERS

Squire Sanders (US) LLP
1200 19th Street, NW
Suite 300
Washington, D.C. 20036

O +1 202 626 6600
F +1 202 626 6780
squiresanders.com

Bruce A. Olcott
T +1 202 626 6615
bruce.olcott@squiresanders.com

August 14, 2013

BY ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street S.W.
Washington D.C. 20554

Re: NextNav, LLC
Permitted Oral *Ex Parte* Notice and Written *Ex Parte* Presentation
PS Docket No. 07-114

Dear Ms. Dortch:

On August 12, 2013, representatives of NextNav, LLC ("NextNav"), met with representatives of the Commission's Public Safety and Homeland Security Bureau to discuss the highly accurate indoor location capabilities of NextNav's positioning service. The parties also discussed the factors that warrant consideration in developing rules for wireless indoor location services. Participating in the meeting on behalf of NextNav were Gary Parsons, Ganesh Pattabiraman, Bruce Cox, and the undersigned. Participating in the meeting on behalf of the Commission were David Turetsky, David Furth, David Siehl, Dana Zelman, Nicole McGinnis, Eric Ehrenreich, and Erika Olsen.

The parties initially discussed NextNav's continued development of enhancements to its indoor location technology in order to improve its accuracy and yield. To document these enhanced capabilities, NextNav contracted with TechnoCom Corporation, the company that conducted the original CSRIC tests, to replicate the CSRIC test process in the Bay Area with equal integrity and rigor. The version of NextNav's technology tested (referenced herein as Rev-2) showed significant average improvement in accuracy as compared to its first generation system, including:

- 20-25 percent improvement in the horizontal dimension across all morphologies,
- 67 percent of calls accurate to within 2 meters in the vertical dimension, and
- Average yield exceeding 98 percent and ranging between 97- 99.9 percent.

NextNav's improvements in its indoor location capabilities come less than a year after the version tested in the original CSRIC Test Bed (November 2012), and only a little more than two years after the Commission concluded that indoor location accuracy is "a significant public safety concern that *requires* development of indoor technical solutions and testing methodologies to verify the effectiveness of such solutions."[1] Since that seminal statement of policy, Working Group 3 of the Commission's CSRIC has studied the issue, including undertaking field tests, and issued a report on the indoor location capabilities of several technologies. Additional test results undertaken separately from the CSRIC process were submitted to the Commission by an additional location technology vendor.[2] The performance capabilities of still other location technologies were studied by CSRIC and were addressed in a separate report that CSRIC filed with the Commission earlier this year,[3] and additional technology vendors have been working outside the CSRIC process to promote to the Commission the indoor capabilities of their location technologies.[4]

Given the significant data that is already available on the technical capabilities of numerous indoor location technologies, it would appear timely for the Commission to initiate a rulemaking to establish appropriate standards for wireless indoor location to support emergency first responders. The development of rules for wireless indoor location accuracy necessitates consideration of numerous factors, including the availability, reliability and accuracy of indoor location technologies as well as the costs of such services. Further, any investigation into wireless location accuracy requirements necessitates consideration of multiple technical factors, including horizontal accuracy, vertical accuracy, and yield. In addition to improving its own technology, NextNav has been monitoring the development of other indoor location technologies. Based on this information and the findings of CSRIC Working Group 3, NextNav provides the

[1] Amending the Definition of Interconnected VoIP Service in Section 9.3 of the Commission's Rules, GN Docket No. 11-117, Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114; E911 Requirements for IP-Enabled Service Providers, WC Docket No. 05-196, *Notice of Proposed Rulemaking, Third Report and Order, and Second Further Notice of Proposed Rulemaking*, FCC 11-107, ¶ 86 (July 13, 2011) (*emphasis added*) ("*Wireless Location Accuracy Second FNPRM*").

[2] *See* Comments of TruePosition, Inc., PS Docket No. 07-114, et. al (Aug. 6, 2013) ("*TruePosition Comments*") (including reports for tests it had conducted on its technology in Delaware, New York and Texas as attachments).

[3] *See Report – "Leveraging LBS and Emerging Location Technologies for Indoor Wireless E9-1-1,"* CSRIC III, Working Group 3 (March 14, 2013) ("*CSRIC LBS Report*").

[4] *See, e.g.*, Letter from Mary L. Brown, Director, Cisco Government Affairs, to Marlene H. Dortch, Secretary, Federal Communications Commission (July 24, 2013) (providing a presentation on the capabilities of Cisco's Wi-Fi location technology as an attachment).

Commission with the following observations regarding what is reasonably achievable by the positioning industry, the timeframe for such capabilities, and the potential costs of indoor location services.

Horizontal Location Accuracy

As the public safety community explained in the CSRIC Test Bed Report, its primary goal for indoor location accuracy is the identification of a "specific dispatch-able building (and floor in multi-story environments)."[5] Quantifying this requirement, the public safety community explains

> [h]orizontal positional fixes that substantially exceed 50 meter accuracy, provides only general location information. Tighter performance is required, particularly in urban and dense urban environments to narrow the search ring to a single building or a more reasonable number of adjacent buildings.[6]

NextNav's Rev-2 technology consistently surpassed public safety's goal of at least 50 meter accuracy, providing search rings of less than 50 meters for at least 67 percent of the calls in each of the critical morphologies – dense urban, urban, and suburban environments.[7] Further, NextNav's Rev-2 technology provided search rings of less than 35 meters for at least 90 percent of calls in suburban environments.

2D Position Accuracy by Morphology, in Meters					
		50%	67%	80%	90%
Dense Urban	**Rev 2** *(June - July 2013)*	34	45	58	81
	Rev 1 *(CSRIC 2012)*	43	57	73	102
Urban	**Rev 2** *(June - July 2013)*	35	47	61	137
	Rev 1 *(CSRIC 2012)*	50	63	85	141
Suburban	**Rev 2** *(June - July 2013)*	12	18	23	33
	Rev 1 *(CSRIC 2012)*	21	29	39	53

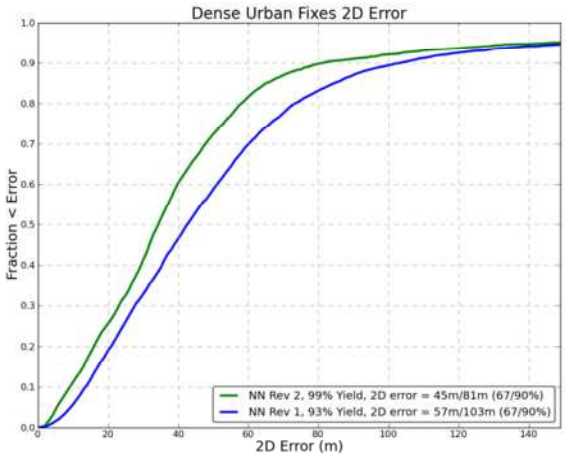
The extent of the improvement in NextNav's Rev-2 technology is further demonstrated in the following cumulative distribution function ("CDF") charts, which provide comparisons

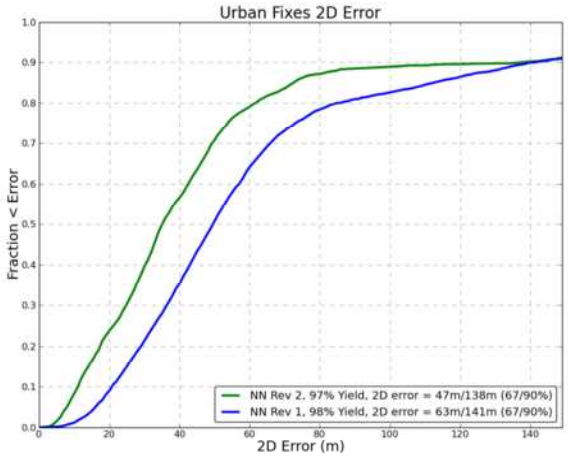
[5] *See* "*Indoor Location Test Bed Report*," CSRIC III, Working Group 3, *Public Safety Forward* at 9 (March 14, 2013) ("*CSRIC Test Bed Report*").

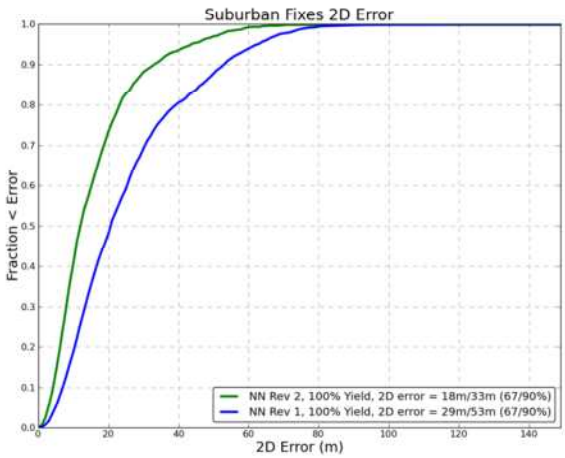
[6] *Id.*

[7] NextNav's Rev-2 system was not tested in a rural environment given the level of performance already documented with its Rev-1 system.

between the original CSRIC test results for NextNav's Rev-1 system as compared to the test results for its Rev-2 system from the identical test points in each of these critical morphologies.







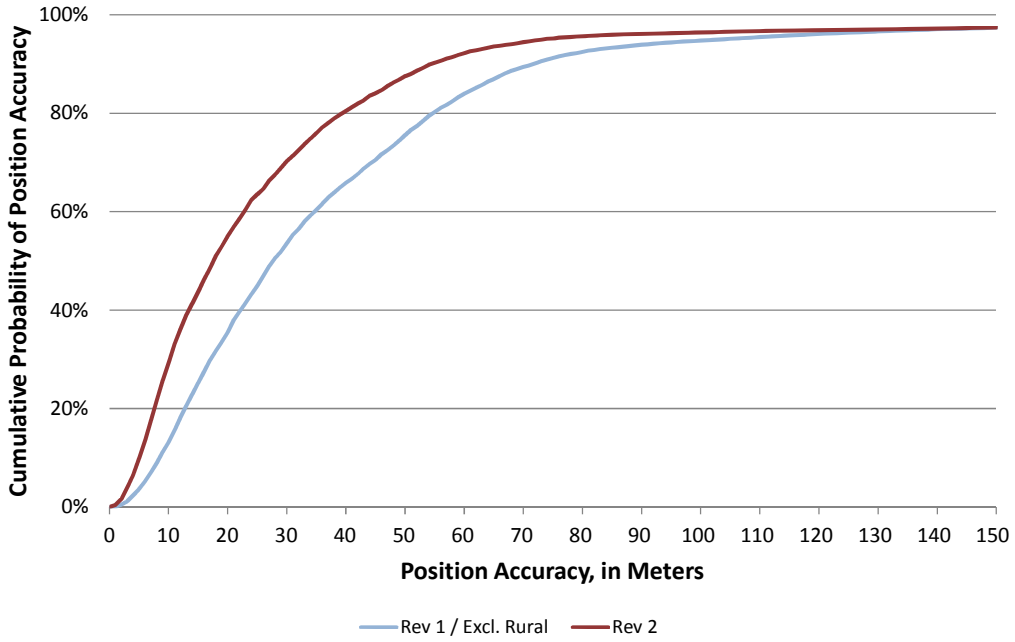
The location accuracy capabilities that the average user will experience in real life will be far better than the statistics presented in the above charts. This is because nearly 70 percent of the indoor test points that were used in the CSRIC process (the same test points used in NextNav's Rev-2 tests) were located in intentionally challenging Dense Urban and Urban settings. In contrast, only about 30 percent of the U.S. population lives in urban areas.[8] Therefore, a more statistically representative indoor testing process across metropolitan areas would weight test points consistent with population densities and would include a more balanced weighting of test points in a suburban-urban mix. Based on the test results compiled from the

[8] *See "Demographic Trends in the 20th Century," Census 2000 Special Reports, Frank Hobbs and Nicole Stoops.*

CSRIC testing, NextNav has included below a table of "population weighted" results that is representative of the mix of suburban-urban across U.S. metropolitan areas based on U.S. census data.[9] The "population weighted" results can be used to reasonably project the performance of a comprehensive testing program across a large number of metropolitan areas, including testing in both the downtown (Urban/Dense Urban) and suburban environments.

POP-Weighted 2D Position Accuracy, in Meters				
	50%	67%	80%	90%
Rev 2 *(June - July 2013)*	18	28	39	54
Rev 1 *(CSRIC 2012)*	28	41	55	72

The populated weighted results are also presented below in the following CDF chart, which provides population weighted comparisons between the original CSRIC test results for NextNav's Rev-1 system as compared to the test results for its Rev-2 system from the identical test points in each of these critical morphologies.



Currently, the Commission's rules for handset-based wireless location services already require accuracy of 50 meters or better for 67 percent of E911 calls received by a wireless carrier and 150 meter accuracy or better eventually for 90 percent of Phase II E911 calls received by a

[9] The U.S. Census describes 30 percent of the population living in urban areas, 50 percent in suburban areas and 20 percent in rural areas. Presented data excludes testing in rural areas, where GPS functions adequately.

carrier.[10] In 2010, the Commission concluded that these requirements would apply only to wireless calls made from outdoor locations pending further study of indoor location capabilities.[11] Given the significant investigation and development that has now been conducted by CSRIC, NextNav and other location technology vendors, it would arguably be appropriate to eliminate the exemption for indoor location of wireless E911 calls and to establish initial indoor location rules that mirror the existing outdoor requirements. In other words, extend the current outdoor rules of 50m/67% and 150m/90% to indoor locations by the effective date of the Commission's rules.

Multiple indoor location technology vendors have already indicated for the record that their technology can satisfy the 50m/67% and 150m/90% requirements for wireless calls to E911 from indoor locations. The CSRIC Working Group 3 LBS Report canvassed technology providers and reported to the Commission that many of those vendors indicated that their technologies could satisfy its Phase II handset-based accuracy requirements in indoor locations, including Navizon's Wi-Fi Access Point location technology,[12] Skyhook's Wi-Fi location technology,[13] NextNav's beacon technology,[14] and CSR's hybrid A-GPS/Wi-Fi technology.[15]

In expressing support for the initial use of the Commission's existing 50m/67% and 150m/90% outdoor requirements, NextNav notes that the Commission also maintains a much more lenient outdoor rule for network-based wireless location services of 100 meters at least 67 percent of the time and 300 meters at least 90 percent of the time. One party has advocated for the use of this standard as the initial indoor requirement.[16] The Commission, however, is in the process of phasing out in 2018 its 100/300 standard for the remaining carriers still using the standard. Further, the Commission previously considered the use of the 100/300 standard for indoor location in a 2011 rulemaking and noted that the far more lenient standard would be inappropriate for use in indoor locations, explaining that

[10] *See* 47 C.F.R. § 20.18.

[11] *See Wireless E911 Location Accuracy Requirements*, FCC 10-176, Second Report and Order, ¶ 29 (Sept. 23, 2010) ("*Wireless Location Accuracy Second Report & Order*").

[12] *CSRIC LBS Report* at 21.

[13] *See id.* at 26.

[14] *See id.* at 33.

[15] *See id.* at 54.

[16] *See TruePosition Comments* at 23.

> since indoor incidents are often not visible to the first responder without entering the building, a location accuracy of 100/300 meters or cell-tower only would only identify the city block in which a building is located, which in urban environments could potentially contain thousands of apartments.[17]

Consistent with this, a key finding of CSRIC III Working Group 3 was that indoor location accuracy and outdoor location accuracy do not require the same standards, and most specifically, from the standpoint of the needs of the public safety community, the desired accuracy for indoor location is greater than that required for outdoor location accuracy due to the inherently greater difficulty in locating calling parties indoors in a metropolitan environment. Therefore, while public safety clearly expressed a desire to have consistent position fixes not substantially greater than 50 meters (and with a vertical component), at a minimum the Commission should initially require indoor accuracy standards no less than the outdoor accuracy standards of 50 meters at least 67 percent of the time and 150 meters at least 90 percent of the time. This could be tightened over time to further increase the percentage of fixes within 50 meters, potentially reaching 80 percent or more at some subsequent milestone. Based on the test results and representations made by multiple location technology vendors, it is reasonable for the Commission to conclude that these targets can be achieved.

Vertical Location Accuracy

The Public Safety Foreword to the CSRIC Test Bed Report observes that "floor level vertical accuracy is valuable in large multi-story structures common in urban and dense urban morphologies."[18] CSRIC's conclusion in this regard is consistent with the long standing position of the public safety community, the representatives of which have been arguing for years that the delivery of vertical-axis position information should be "required for future-generation networks and devices, under uniform standards."[19]

Consistent with public safety's views, the Commission has been considering the potential benefits of adopting vertical location accuracy requirements ever since its rules for wireless location accuracy were first proposed. In the Commission's 1994 Notice of Proposed Rulemaking on wireless location requirements, the Commission tentatively concluded that its

[17] *See Wireless Location Accuracy Second FNPRM*, ¶ 86.

[18] *CSRIC Test Bed Report* at 8.

[19] *Comments of NENA, the E9-1-1 Association*, Docket Nos. 05-196 & 07-114, at 11 (filed Jan. 19, 2011).

proposed locations rules should be applicable to both the horizontal and vertical dimensions.[20] The Commission did not include the vertical requirement in the rules that it adopted in 1996, however, based on arguments from commenters that reasonably accurate vertical information may not be technically achievable within the immediate five years and would primarily benefit public safety only in downtown areas of major cities.[21] Since that time, however, location technology has advanced substantially and the potential public safety benefits of vertical location information have been more thoroughly documented.

NextNav's Rev-2 capability demonstrated significant improvement in vertical location accuracy in each of the critical morphologies. As indicated in the chart below, NextNav's Rev-2 system showed far more consistent results across various morphologies, eliminating some of the variation in accuracy that was documented for NextNav's initial system during the CSRIC testing. As a result, NextNav has proven it can reliably provide about 1 to 2 meter vertical accuracy for at least 67 percent of E911 calls regardless of morphology.

Vertical Position Accuracy by Morphology, in Meters					
		50%	67%	80%	90%
Dense Urban	**Rev 2** *(June - July 2013)*	1.6	2.3	3.2	4.5
	Rev 1 *(CSRIC 2012)*	2.2	2.9	3.4	4.0
Urban	**Rev 2** *(June - July 2013)*	1.5	1.8	2.2	2.7
	Rev 1 *(CSRIC 2012)*	1.3	1.9	2.3	2.8
Suburban	**Rev 2** *(June - July 2013)*	1.0	1.5	2.3	2.9
	Rev 1 *(CSRIC 2012)*	3.9	4.6	5.0	5.5

Given the critical need for vertical location information to support emergency first responders, the Commission should consider the adoption of vertical location requirements. The CSRIC report on leveraging LBS and emerging technologies noted several technologies capable of providing vertical location accuracy including Observed Time Difference of Arrival technologies,[22] Distributed Access System proximity-based location technologies,[23] and hybrid

[20] Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems, CC Docket 94-102, RM-8143, *Notice of Proposed Rulemaking*, 9 FCC Rcd 6170, 6178-79 (¶¶ 49-51) (1994).

[21] *See* Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems, FCC 96-264, *Report and Order and Further Notice of Proposed Rulemaking*, ¶ 70 (July 26, 1996) ("*First Report & Order*").

[22] *CSRIC LBS Report* at 37 and 40.

[23] *See id.* at 49.

A-GPS technologies.[24] Further, while NextNav's particular approach to vertical accuracy involving real-time calibration of pressure sensors was the only approach proven in the CSRIC test-bed to provide the above demonstrated accuracy, the underlying use of miniature pressure sensors in handsets is a technique numerous other vendors have noted can be supported by their systems as well.[25]

Given these facts, it is reasonable to conclude that, by the effective date of the Commission's rules, indoor location services could support vertical location accuracy requirements in the range of 3 to 5 meters. Further, these capabilities could eventually be strengthened to within 3 meters over time (generally considered as "floor level" or "near floor level" accuracy) and would truly fulfill the express and critical needs of emergency first responders.

Call Location Yield

A critical component of indoor location accuracy is ensuring that a position fix is yielded for all wireless calls made to E911 from indoor locations. As explained by some of the participates in the CSRIC Working Group 3 report on outdoor location testing, "[a]ccuracy testing that ignores or side-steps [the issue of yield] can present an inaccurate and misleading picture of the accuracy that will *actually be delivered to the public safety community*."[26] This continuing disparity in the percentage of E911 calls that are delivered to PSAPs without critical Phase II location information was highlighted strongly with the recent publication of a CALNENA study of wireless calls to E911 during the previous four years.[27] The increasingly low yield for Phase II call information that was documented in the study, most notably in urban markets, demonstrates the rapidly accelerating problem of blockage of GPS satellite signals indoors and in urban environments and the resulting impact on the accuracy of first responder dispatch information. As CALNENA explains, although the problem of increasingly low yield is "widespread" the trend is much worse in urban areas where "GPS signals are known to struggle

[24] *See id.* at 54.

[25] *Id.* at 53 (noting CSR's use of MEMs pressure sensors for vertical location information); Comments of TruePosition, PS Docket 07-114, et. al, at 24 n.46 (asserting that pressure sensors "can be used with any location technology solution" to provider vertical location information).

[26] *Final Report – Outdoor Location Accuracy*, CSRIC III, Working Group 3, at 29 (March 14, 2012) ("*CSRIC III Outdoor Location Report*") (*emphasis in original*).

[27] *See Letter from Danita L. Crombach, Communications Manager for the Ventura County Sheriff's Office, to The Honorable Mignon Clyburn, Chairwoman, Federal Communications Commission, August 12, 2013.*

to penetrate inside metal, stone and concrete structures or reach cell phones outside in the urban 'canyons' created by high-rise buildings."[28]

One of the key technological improvements incorporated into NextNav's Rev-2 implementation is the use of an assisted mode of operation (similar to A-GPS) to allow timing and ranging information to be extracted from signals which were too weak to demodulate. This technique provided very high yield statistics in the range of 97 to 99.9 percent depending on morphology, a tangible improvement as compared to the 94 to 95 percent Urban and Dense Urban yield achieved in the original CSRIC testing.

Yield Statistics (in %)		
Morphology	**NextNav Technology**	**Yield**
Dense Urban	Rev2 (June-July 2013)	99%
	Rev1 (CSRIC Fall 2012)	93.90%
Urban	Rev2 (June-July 2013)	97.30%
	Rev1 (CSRIC Fall 2012)	95.40%
Suburban	Rev2 (June-July 2013)	99.90%
	Rev1 (CSRIC Fall 2012)	100%

Given the impressive yield results that have been demonstrated by multiple vendors of indoor location services,[29] it would appear reasonable for the Commission to conclude that if a wireless device is able to place an E911 call from an indoor location, the indoor location service provider should be able to provide a location fix for that device in the vast majority of cases.

The issue of yield has particular relevance to indoor location accuracy requirements because of the variability in which yield is accommodated in existing *outdoor* location accuracy testing. This topic was fully discussed in the CSRIC Working Group 3 report on outdoor testing.[30] One of the opinions expressed by some of the Working Group 3 participants was that location testing programs could permissibly apply the 67m/90% accuracy calculations only to E911 calls that achieved Phase II fixes and ignore or discard any E911 calls that achieved only Phase I fixes from the calculations.[31] Although there was significant disagreement within Working Group 3 regarding whether or not the results from *all* outdoor test calls must be

[28] *Id.* at 3.

[29] *See, e.g., CSRIC Test Bed Report* at 54 (noting that "all technologies tested demonstrated relativity high yield and various levels of accuracy in indoor environments").

[30] *See CSRIC Outdoor Location Report* at 28-30.

[31] *See id.* at 29.

included in the reported results (including calls that could not achieve a Phase II fix), the parties agreed that the issue was especially critical to appropriate indoor testing (where AGPS would likely provide only a limited percentage of successful fixes).[32]

Regardless of whether the Commission resolves this confusion by clarifying its rules for outdoor location accuracy, the Commission should ensure that its rules for indoor location accuracy avoid the potential for such confusion. Ideally, this would be achieved by requiring that all E911 test calls from wireless handsets be included in the calculations that are used to determine whether the applicable standard (*i.e.*, 50m/67% and 150m/90%) has been satisfied. Alternatively, the Commission might conclude that only the universe of Phase II fixes be included in testing accuracy calculations (as was done in the CSRIC test-bed report), but that any indoor testing program achieve an acceptably high yield (95 percent as an example) to be deemed compliant with the Commission's requirements.

The practical implications of a significant disparity in yields between different technologies is that comparing accuracy statistics between a technology achieving 99 percent yield versus one achieving 90 percent yield is relatively meaningless, particularly at the 90th and 95th percentiles. The latter technology may report average accuracy statistics that are as good as or better than the former technology because the former technology's accuracy statistics may be burdened by the potentially poor location fixes that were achieved for the 9 percent of calls that the latter technology failed to yield and therefore didn't count.

Population Coverage

Emergency first responders in every region of the country would obviously benefit from reasonably accurate indoor location information for wireless E911 calls. The problem of locating wireless callers indoors in emergencies, however, is clearly most severe and growing in urban centers, particularly in those with tall densely spaced buildings and where relatively large numbers of renters and low income individuals (those most likely to forego wireline telephone service) reside. Therefore, it would be reasonable for the Commission to respond to the most pressing needs of public safety by implementing indoor location accuracy on a geographically phased-in or population-density basis.

The Commission should consider requiring compliance with horizontal and vertical accuracy requirements based on percentage of the population in each wireless carrier's service territories. For example, a wireless carrier could make indoor location capabilities available to some initial percentage of the population in its service territory (such as 25 percent) by the effective date of the rules, with increasing percentages required at subsequent anniversary dates. Carriers should be incentivized to satisfy these requirements by making indoor location capabilities available first in the most densely populated areas of their service territories, thus

[32] *See id.*

ensuring that indoor location capabilities are available first in the areas where the proven need is greatest.

Indoor Location Effective Date

The various indoor location accuracy factors that are discussed in the prior sections of this letter are premised on implementation milestones that would follow the effective date of the Commission's indoor location rules. NextNav believes that the effective date that is adopted by the Commission must provide reasonable implementation time for wireless carriers to work with vendors of location accuracy technologies to ensure their compliance with the Commission's rules without incurring unnecessary expenses in an effort to deploy technologies in excessive haste. At the same time, the public safety community and the CSRIC advisory group has clearly indicated that the scope of the indoor location accuracy problem is already critical and continues to grow.[33] Therefore, NextNav suggests that the Commission consider an initial effective date of January 1, 2016, which would provide the wireless community with at least two years (assuming the rules are adopted this year) to achieve initial compliance.

Verification Testing

As the Commission has acknowledged throughout its deliberations on wireless indoor location rules, any accuracy requirements that are adopted must be combined with "testing methodologies to verify the effectiveness of such solutions."[34] Indoor location testing, however, is inevitably much more difficult than outdoor testing, which can be performed using drive testing or other techniques. Some have suggested that indoor location technologies can be verified using outdoor test results that can be used "to estimate indoor location accuracy."[35] The consensus conclusion of the CSRIC Working Group 3 participants, however, was that no effective substitute exists to some level of representative indoor testing in order to verify the capabilities of indoor location technologies.[36]

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[33] *See CSRIC III WG3 Final Report*, at 7 (June 1, 2012) ("*CSRIC 2012 Report*").

[34] Amending the Definition of Interconnected VoIP Service in Section 9.3 of the Commission's Rules, GN Docket No. 11-117, Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114; E911 Requirements for IP-Enabled Service Providers, WC Docket No. 05-196, *Notice of Proposed Rulemaking, Third Report and Order, and Second Further Notice of Proposed Rulemaking*, FCC 11-107, ¶ 86 (July 13, 2011) (*emphasis added*).

[35] *See* Letter from James Arden Barnett, Jr., to Marlene H. Dortch, Secretary, Federal Communications Commission, at 2 (July 16, 2013) (disclosing ex parte meeting involving TruePosition on, *inter alia*, indoor location testing).

[36] *CSRIC Test Bed Report* at 52; *CSRIC 2012 Report* at 7 and 10.

Granted, securing access to representative buildings in a service territory is not a simple process. As the CSRIC Test Bed Report explained, securing building access was "one of the biggest challenges" that the working group faced in its indoor location accuracy test process.[37] For this reason, the Public Safety Foreword to the CSRIC Test Bed Report concluded that "wide-spread indoor accuracy testing is not practical."[38] The CSRIC public safety participants concluded, however, that "[a] process of small-scale test beds and statistical sampling mutually designed and agreed upon by public safety, location determining equipment vendors and wireless carriers" could be used to test the capabilities of indoor location technologies.[39] Further, the CSRIC participants also discovered that local emergency service agencies, such as the San Francisco Fire Department and the Department of Emergency Management could be extremely helpful in securing access to buildings for testing.[40]

Therefore, NextNav suggests that the Commission propose indoor location test requirements that include physical testing inside a representative sampling of building construction types and locations in a representative set of communities across the country, with testing points weighted to reflect the population densities of the tested area. This limited physical testing, combined with a process of characterization of local building types and conditions, could be used to extrapolate and demonstrate that the representative test results can be reliably applied to the characterized homogeneous community. The public safety participants in the CSRIC Working Group 3 process have repeatedly expressed, both in the case of outdoor testing as well as indoor testing, a willingness to accept empirical testing that establishes representative environments, and then largely relying on key performance indicators to identify areas where further testing is required.[41]

Granted such a process may be time consuming for the initial validation and representative characterization, but it would not need to be repeated with significant frequency, necessitating re-testing only in the case of degradation of the key performance indicators, a change in the location technology, or antidotal evidence that an existing location technology is not performing reliably.

[37] *CSRIC Test Bed Report* at 50.

[38] *Id.* at 9.

[39] *Id.*

[40] *See id.* at 50.

[41] *See id.* at 9.

Cost Considerations

Another consideration that NextNav addresses herein is the cost/benefit analysis of deploying indoor location technologies. The Commission long since appropriately concluded that wireless carriers must provide accurate location information to public safety regarding wireless callers to E911 and that the costs of enabling such capabilities is warranted given the substantial benefits that would result. Now that an increasing number of wireless calls to E911 are transitioning to indoor locations, the Commission's pre-existing conclusion logically extends to indoor locations as well to ensure that emergency first response capabilities are maintained at the levels that consumers justifiably expect.

Fortunately, available evidence indicates that indoor location technologies can be deployed and maintained at very reasonable cost. As identified in Sections 13.3 and 13.4 of the CSRIC Test Bed Report, in assessing the potential costs of enabling indoor location capabilities, significant areas of consideration are network infrastructure costs, carrier network and systems costs, and handset costs.[42] On the first issue, a major factor in minimizing the potential cost of indoor location infrastructure is the ability of many technical solutions to be shared by multiple wireless carriers. As the CSRIC Test Bed Report explained, the use of a "shared infrastructure approach, like GPS, helps ensure the cost of the service is competitive."[43]

Second, terrestrial beacon-based solutions such as NextNav and others[44] employ a one-way multilateration approach to location identification that greatly reduces the number of transmitters required to establish an indoor position fix for tracked handsets. Through the use of high site locations surrounding urban centers, augmented by select roof-top locations, a relatively small number of terrestrial beacons can enable indoor location in an entire metropolitan area. The construction and operating costs for such a network are vastly less than for two-way cellular networks, which require more densely placed transmitters to meet capacity and coverage requirements. In contrast, in a broadcast-only location network, no additional transmitters or spectrum is needed as the number of users on the network increases. Further, the low-cost network equipment does not require expensive backhaul facilities nor elaborate antenna arrays.

The next potential cost consideration identified in the CSRIC Test Bed Report was the impact on the networks of wireless carriers (both deployed Radio Access Networks (RANs) as well as back-room processing networks to route E911 calls to PSAPs and provide associated location information). This, of course, includes not only the capital costs of deploying technology in radio transmission networks, but also the ongoing maintenance costs of those

[42] *See id.* at 53.

[43] *See id.* at 45.

[44] *See TruePosition Comments* at 15 (stating that TruePosition is developing a terrestrial beacon system utilizing digital TV signals).

technologies and any associated databases. In this respect, the carriers noted the importance of technical approaches that do not require equipment additions to their networks, are not tied to a particular generation of their transmission network (2G, 3G, 4G, etc.), and which utilize the existing control plane call flow process of existing E911 calls. The NextNav technical approach has been designed, like GPS, to overlay any or all carriers' transmission networks with no modification to the carrier's radio communications equipment, and to follow the existing E911 call flow with minimal standards and core network impacts.

A final consideration in the deployment of indoor location capabilities is potential adaptations to the handset. Granted, the handset modification costs for various indoor location services differ by the technology employed. With respect to NextNav's service, the multilateration beacon signal was designed to emulate a GPS signal thus making it compatible with GPS chipsets that already exist in all, if not nearly all, wireless handsets. As noted in the CSRIC Test Bed Report, NextNav is currently working with various GPS chipset manufacturers to include NextNav capability as an inherent part of their GPS functionality.[45] Although certain discrete RF components are required to ensure NextNav's 900 MHz signal is routed to the GPS chip, the cost of these discrete elements is negligible.

With respect to the vertical aspect of NextNav's location capability, NextNav is using readily available atmospheric pressure sensors in each wireless handset and is providing real-time calibration over-the-air through its beacon network in order to improve accuracy. Samsung already includes atmospheric pressure sensors in some of its most popular smartphones,[46] and they are also common in tablets, sports and exercise watches and other consumer devices. Analysts estimate that the inclusion of atmospheric pressure sensors in Smartphones is expected to increase to 681 million new units per year in 2016, up more than eightfold from 82 million new units per year in 2012.[47] Such sensors are relatively inexpensive already and should be expected to fall well below $1 at the volume levels that analysts are projecting.

Given these facts, a strong argument can be made that the costs of making indoor location information available to support emergency E911 is not excessive and is clearly reasonable given the importance of ensuring that emergency first responders have accurate dispatch information in order to respond promptly to the needs of individuals in distress. The Commission is therefore acting within its reasonable discretion and authority to adopt such requirements in the near term.

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[45] *See CSRIC Test Bed Report* at 42.

[46] http://singularityhub.com/2013/04/01/sensors-in-smartphones-galaxy-s4-adds-pressure-temperature-and-humidity-sensors; http://www.popsci.com/gadgets/article/2011-10/so-um-why-does-new-google-phone-have-barometer-it

[47] http://www.electronics-eetimes.com/en/samsung-leads-the-adoption-of-pressure-sensors-in-smartphones-for-floor-accurate-indoor-geolocation.html?cmp_id=7&news_id=222916211.

Public Interest Mandate

In fire, public safety, and medical emergencies, "time is of the essence."[48] Myriad public safety entities from national to local, including fire, police, EMS, and consumer groups agree that "accurate caller location information to [PSAPs] speeds dispatch, saving lives and property."[49] Unfortunately, as first responders and the Commission are well aware, "[c]ell phone calls from indoors and in urban canyons are often unable to report accurate information in a timely manner, if at all."[50] Despite the improvements in E911, "current generation location technology is often unable to accurately locate callers indoors, especially in multi-story buildings. This shortcoming increases when the size of buildings grow."[51] "Mobile phones are used for more than 70 percent of 9-1-1 calls, and many of these calls are placed indoors where location information is often unreliable or unavailable."[52]

JD Power reported that the percentage of wireless calls originating from indoor locations jumped to nearly 60 percent in 2012, up from 40 percent in 2003.[53] The Commission recognized the trend of increased wireless calling and the importance of achieving accurate location information when it first proposed rules requiring location information in 1994.[54] At the time, around 24 million subscribers were using wireless phones, but the number of subscribers was already increasing by nearly 10 million per year.[55] Today, the number of wireless subscribers

[48] Comments of the Professional Firefighters Association of New Jersey, WT Docket No. 11-49, at 1 (April 3, 2013) ("*PFANJ Comments*").

[49] *Id*.

[50] *Id*.

[51] Comments of Telecommunications for the Deaf & Hard of Hearing, Inc., WT Docket No. 11-49, at 2 (April 12, 2013) ("*TDHH Comments*"); *see also* Comments of the International Association of Fire Fighters, WT Docket No. 11-49, at 1 (March 25, 2013) ("*IAFF Comments*") (explaining that "signal reception challenges presented by large institutional structures and tall buildings can also delay the arrival of assistance when emergency responders cannot locate victims quickly").

[52] Comments of the International Associations of Chiefs of Police, WT Docket No. 11-49, at 1 (March 29, 2013).

[53] *See* http://www.jdpower.com/content/press-release/p5rCap4/2012-u-s-wireless-network-quality-performance-study-volume-1.htm (last visited on Aug. 13, 2013).

[54] *First Report and Order*, ¶ 6.

[55] *See id.*

has continued to increase exponentially, with more than 326 million wireless devices in use in 2012,[56] and with an even greater percentage increase in the number of wireless E911 calls (from less than 18 million wireless E911 calls in 1994[57] to more than 145 million wireless E911 calls in 2012).[58] The rapid transition of consumers to an overwhelming reliance on wireless devices for critical communications such as reaching E911 emergency services is clear and the status quo of unreliable location services for wireless calls made indoors is untenable for both the public and for emergency first responders.

Public safety entities have repeatedly expressed the need for Commission action to facilitate near term improvements in indoor location accuracy. The CSRIC Test Bed Report underscored the basic requirement that location technologies be able to provide "actionable location" data, which effectively means "a specific dispatch-able building and floor," or generally "the smallest possible search ring." [59] National, state, and local public safety organizations echo these sentiments. The State of Connecticut Department of Emergency Services notes that "the replacement of wire line telephony by wireless devices for many of our citizens has underlined the need for accurate location information inside of buildings, including 'z' axis information."[60] The Minnesota Department of Emergency Services notes that the "accuracy provided by current E911 location technologies is often dramatically insufficient, providing search rings which can contain multiple city blocks and include thousands of apartments in multistory buildings."[61] These limitations are particularly acute for callers that may be unable to provide additional location information. Advocates for the deaf and hard of hearing note that it is critical that the Commission ensure that the 911 system meet the expectations of consumers that when they call 911, first responders will be able to locate them

[56] *See* CTIA, Wireless Quick Facts, Year-End Figures, *available at* http://www.ctia.org/media/industry_info/index.cfm/AID/10323 (last visited Aug. 13, 2013) ("*CTIA Year-End Figures*").

[57] *First Report & Order*, ¶ 6.

[58] *See CTIA Year-End Figures*.

[59] *CSRIC Test Bed Report* at 9.

[60] Comments of the State of Connecticut Department of Emergency Services and Public Protection, PS Docket Nos. 10-255, 11-153, and 12-333, at 8 (Dec. 12, 2012).

[61] Comments of the Minnesota Metropolitan Emergency Services Board and the Minnesota Department of Public Safety, WT Docket No. 11-49, at 1 (April 18, 2013); *see also* Comments of the National Sheriffs' Association, WT Docket No. 11-49, at 1 (April 3, 2013) (noting that "[i]mproving the ability of dispatchers and first responders to locate [indoor] callers has become an important public safety issue").

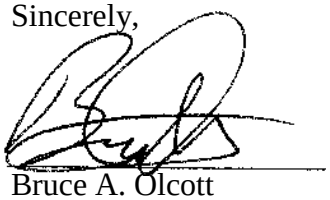
regardless of the device or location from which the call originates.[62] NENA has further explained that "[a]ny significant improvement over the current regime of impossibly-large outdoor search rings and indeterminate indoor search rings must be encouraged, whether or not it can reach our ultimate ideal right away."[63]

The unreliability and unavailability of indoor location information affects not just potential victims, but also first responders. The International Association of Fire Fighters explains that the same indoor location accuracy technology that can improve safety for 911 callers "would be equally valuable to incident commanders seeking to maintain situational awareness and personnel management."[64] Technology which can "provide the capability to both rapidly locate victims and fallen rescuers, with precise horizontal and vertical accuracy, indoors and out, can only improve first responder performance, safety and outcomes."[65]

The need for improved location accuracy in urban areas is clear, particularly in those places that current generation technologies are least available, such as indoors in large buildings. Fortunately, as demonstrated above, next generation technologies are currently available to fill this critical need. The Commission should therefore heed the call of the public safety community to take the steps necessary to ensure this improved information is available to consumers and first responders without delay.

Thank you for your attention to this matter. Please contact the undersigned if you have any questions.

Sincerely,



Bruce A. Olcott
Counsel to NextNav, LLC

[62] *TDHH Comments* at 1-2.

[63] *Comments of NENA, the E9-1-1 Association,* WT Docket No. 11-49, at 2 (March 22, 2013).

[64] *IAFF Comments* at 2.

[65] *PFANJ Comments* at 1-2.